

# **MARKSCHEME**

**May 2003**

**BIOLOGY**

**Higher Level**

**Paper 3**

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## General Marking Instructions

### Subject Details:      **Biology HL Paper 3 Markscheme**

#### Mark Allocation

Candidates are required to answer **ALL** questions in each of **TWO** Options (total **[20 marks]**).  
Maximum total = **[40 marks]**.

#### General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- ◆ Each marking point has a separate line and the end is signified by means of a semicolon (;).
- ◆ An alternative answer or wording is indicated in the markscheme by a “/”; either wording can be accepted.
- ◆ Words in ( ... ) in the markscheme are not necessary to gain the mark.
- ◆ The order of points does not have to be as written (unless stated otherwise).
- ◆ If the candidate’s answer has the same “meaning” or can be clearly interpreted as being the same as that in the mark scheme then award the mark.
- ◆ Mark positively. Give candidates credit for what they have achieved, and for what they have got correct, rather than penalising them for what they have not achieved or what they have got wrong.
- ◆ Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with “**ECF**”, error carried forward.
- ◆ Units should always be given where appropriate. Omission of units should only be penalized once. Indicate this by “**U-1**” at the first point it occurs. Ignore this, if marks for units are already specified in the markscheme.
- ◆ Do not penalize candidates for errors in significant figures, unless it is specifically referred to in the markscheme.

**Option D – Evolution**

- D1.** (a) (i) *A. afarensis* because smallest brain / less similar / smallest female;  
*A. robustus* because smallest male body mass; [1 max]
- (ii) fossil of body not found / incomplete / only skull found / fossil not in good condition; [1]
- (b) the largest primate in the table (*Gorilla gorilla*) is found amongst modern African apes;  
*Australopithecus* smaller than *Homo*;  
 modern African apes have a greater range of body mass (than the other groups);  
 all male primates larger than females / *Australopithecus* have generally a bigger difference between male and female body mass than *Homo*; [2 max]  
*Do not accept comparisons within the same group of primate.*
- (c) supported by:  
*Homo* and *Australopithecus* / hominids are bipedals;  
 modern apes walk on four legs;  
*Homo* have larger brain than *Australopithecus* / brain size does increase in hominids;  
 brain size expansion particularly great from 2.4 Myr / *H. habilis* to *H. erectus*,  
when bipedalism is already established;  
 but there is insufficient data in the table on bipedalism; [3 max]  
*Do not award a mark for “supported”.*
- D2.** (a) named example;  
 selective pressure;  
 result;  
*example*:  
 beaks of Galapagos finches;  
 competition for food;  
 change in numbers / proportion of birds with different sized beaks; [2 max]
- (b) time taken for half the radioactive atoms in a sample to decay / mass to be reduced by half; [1]

- .D3.** (a) deletion (of 3 nucleotides);  
affects chromosome 7 (carries CFTR);  
ill in homozygous / heterozygous are carriers;  
frequency of disease up to 1 in 2500 births;  
lack of one amino acid (phenylalanine) / frameshift;  
mutation in protein essential for chloride transport;  
mucus secretions too viscous;  
clogging of lungs / breathing impeded / recurrent respiratory infections / children need physiotherapy;  
blockage of pancreatic duct / excess chloride / salt in sweat / infertility / diabetes / obstruction of gut / children need digestive enzymes;

[4 max]

- (b) mathematical model for genetic equilibrium / from which predictions can be made;  
used for sexually reproducing species / breeding must be random / population large / no migration / no selection / no mutation;  
used to calculate allele / genotype frequency;  
by sampling from a population;  
allele frequencies / genotype frequencies remain constant through generations / no change;  
if there is an observed change it suggests evolution is occurring (*do not accept just natural selection*) / population is no longer in equilibrium;  
p and q represent the frequencies of two alleles of a gene;  
frequency of alleles adds to 1 /  $p + q = 1$  ;  
random combination in alleles in mating /  $(p + q)^2$  ;  
(genotype frequency)  $p^2 + 2pq + q^2 = 1$  ;  
 $p^2$  and  $q^2$  are the frequencies of the homozygotes and  $2pq$  is the frequency of the heterozygotes;

[6 max]

**Option E – Neurobiology and Behaviour**

- E1.** (a) autonomic nervous system / involuntary;  
sympathetic releases noradrenalin;  
parasympathetic releases acetylcholine;  
sympathetic increases (amplitude and rate of) heart beat (in order to send more blood to body);  
parasympathetic decreases to resting level / returns heart beat to normal level;  
sympathetic inhibits secretion of saliva;  
parasympathetic stimulates secretion (which helps in digestion);  
parasympathetic contracts circular muscles of iris / constricts pupil (so less light in eye);  
sympathetic contracts radial muscle of iris / dilates pupil (so more light in eye / better vision); **[7 max]**
- (b) small peptides;  
are neurotransmitters;  
act in central nervous system;  
bind with opiate receptors;  
released to inhibit activity of neurons concerned with pain;  
destroyed at synapse / do not act for long;  
opiates (heroin) act in a similar way; **[3 max]**
- E2.** (a) positive correlation / larger head, more copulations / direct relation; **[1]**
- (b) larger head, more wins;  
rarely / one time a smaller head won;  
rarely / four times same size head won; **[2 max]**
- (c) larger head wins more fights so more chances to copulate;  
larger head chosen by female more times / more copulations;  
wide spread of data for courtship success means data is less reliable / position of best fit line can be questioned; **[3 max]**
- E3.** A: cone;  
B: rod;  
C: (cell body of) bipolar neuron; **[2 max]**  
*Three correct [2], two or one correct [1].*
- (b) (i) instinct / stereotyped / genetically determined / not learnt / inherited; **[1]**
- (ii) breathing control / heart rate control / reflex control / blood pressure control  
/ swallowing / coughing / production of saliva; **[1]**

**Option F – Applied Plant and Animal Science**

- F1.** (a) 6 ( $\pm$  2) (%); [1]
- (b) only ripe transcribe PG mRNA / ripe tomatoes produce more PG mRNA than unripe;  
band at 1.77 kb only in ripe; [2 max]
- (c) no effect on unripe fruit;  
band at 1.77 kb much smaller in transformed / less PG mRNA produced in transformed ripe fruit;  
antisense mRNA combines with sense mRNA;  
inactivating the translation / less translation;  
less PG to solubilize pectin of wall;  
fruit takes longer to ripen; [3 max]
- F2.** (a) plowing / transport / food / fur / skins / pets / zoos / seeing eyes dogs / other valid example; [1]
- (b) (i) crosses between plants of different species (*e.g.* modern wheats); [1]
- (ii) named example (*e.g.* tomato, wheat, sugar beet, bagworm moth);  
alteration of number of chromosomes (euploidy) / three (or more) sets of chromosomes;  
larger nuclei / larger cells;  
larger organisms / more vigorous;  
(generally) infertile;  
allopolyploidy when of different species; [2 max]
- F3.** (a) water culture / no soil;  
roots on polyethene / plastic tubes / vermiculite;  
salts added / nutrient solution / any named nutrient solution (*e.g.* Sachs) / fertilizer;  
greater control of environment;  
yield increased; [3 max]
- (b) selection of suitable meristem (explant) / stem segment / bud / single cell;  
sterilization (in sodium hypochlorite solution or other disinfectant);  
transfer to nutrient (basal) medium / solidified agar;  
medium contains salts (nitrates) / sugars / amino acids / vitamins;  
(when buds elongate) transferred to multiplication medium;  
promotes elongation / contains IAA (indole acetic acid);  
growth promotion / mitosis stimulated / contains cytokinin / kinetin;  
callus formed (if cytokinins low);  
cloning / sub-culturing;  
rooting medium / root development / IAA, IBA, NAA;  
potted (in compost); [7 max]

### Option G – Ecology and Conservation

- G1.** (a) electromagnetic radiation / wavelengths of 200 to 400 nm;  
 mutations in DNA / forms free radicals;  
 (pyrimidine) dimer formation / bend or kink in DNA;  
 DNA repair system not functioning;  
 (benign and malign) tumors / skin cancer / xeroderma pigmentosum;  
 sunburn / cataract / destruction of folic acid;  
 UV light converts (ergosterol) to vitamin D / sun tan / radiotherapy; [4 max]
- (b) anaerobic / oxygen free;  
 fermentation tank;  
 warm temperature (30–40°C);  
 raw material organic wastes / excreta / leafy remains / straw / bagasse / peelings of fruit / vegetables;  
 organic molecules (proteins, carbohydrates, fats) transformed into alcohol, carbon dioxide, fatty acids and hydrogen / hydrolysis of organic molecules;  
 formation of acetic / ethanoic acid by acidogens;  
 methanogenic bacteria (*Methanococcus*, *Methanobacterium*, *Methanospirillum*, others);  
 methane produced from (reducing)  $\text{CO}_2$  and  $\text{H}_2$  /  $\text{CO}_2 + 4\text{H}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O}$ ;  
 acetate / ethanoic acid split to produce methane (and  $\text{CO}_2$ ) /  $\text{CH}_3\text{COOH} \rightarrow \text{CH}_4 + \text{CO}_2$ ;  
 (balanced equation not required)  
 affected by detergents / high fatty acid concentrations / heavy metal ions / low pH; [6 max]
- G2.** (a) 30 ( $\pm 1$ ) squirrels hectare<sup>-1</sup>; [1]
- (b) population decreases from 12 ( $\pm 1$ ) squirrels hectare<sup>-1</sup> to 2 ( $\pm 1$ ) in food addition area;  
 in food addition plus predator exclusion area decreases from 30 ( $\pm 1$ ) to 2 ( $\pm 1$ );  
 reaches same level as control (in 2 years);  
 other numerical comparison; [2 max]
- (c) addition of food and exclusion of predators results in more squirrels as conditions are ideal;  
 squirrels can feed well and are not predated / higher reproduction rate;  
 food addition alone also results in more squirrels;  
 because food affects population growth more than predator exclusion (squirrels climb, hide);  
 no additional food but predator excluded does not confirm the hypothesis; [3 max]
- G3.** (a) organic matter of organism after respiration (and metabolism) have been fuelled;  
 net production = gross production – respiration; [1 max]
- (b) A: decomposers / saprophytes / putrefying bacteria;  
 B: nitrifying bacteria / *Nitrobacter*;  
 C: nitrogen fixing bacteria / *Rhizobium* (symbiotic) / *Azotobacter* (free-living) cyanobacteria (blue-green algae) / other nitrogen fixing bacteria; [3]



**Option H – Further Human Physiology**

- H1.** (a) mean permeability for G1 (halotane) changes little / from 1.25 to 1.3 ( $\pm 0.1$ ) % but the mean permeability for G2 (isoflurane) increases / from 0.75 to 1.10 ( $\pm 0.1$ ) %; deviation for permeability of G1 changes little / 0.7 to 0.8 % but the deviation for the permeability of G2 increases / 0.4 to 0.7 %; [2]
- (b) conflicting data;  
G2 has difference but not G1, so can not say inhaled anesthetics cause change;  
G3 has more difference than G1 (although not significant), so inhaled less harmful than intravenous;  
not enough data / all start at different mean / patients not all the same; [3 max]
- (c) higher rate / more clearing / results not exact / greater risk to asthmatics / unethical; [1]
- H2.** (a) *Award [1] for any two of the following.*  
salt (sodium chloride);  
potassium chloride;  
bicarbonates /  $\text{NaHCO}_3^-$  /  $\text{HCO}_3^-$ ;  
calcium salts;  
phosphate salts;  
thiocyanates;  
oligoelements (metals);  
amylase (ptyalin);  
galactosidases;  
blood group substances (ABO);  
antibodies;  
hydrochloric acid inhibitors;  
mucus (mucopolysaccharides, mucoproteins);  
lysozyme; [1 max]
- (b) hepatic artery (carries  $\text{O}_2$ ) into liver;  
hepatic portal vein (carries food) into liver;  
flows into sinusoids / open channels / blood spaces;  
blood leaves through hepatic vein; [3 max]

- H3. (a)** *Award [2 max] for peptide hormone and [2 max] for steroid hormone.*  
named example of peptide hormone (all hormones of the hypothalamus and pituitary and pancreatic hormones insulin, glucagon and somatostatin);  
receptors on cell membrane;  
does not enter cell;  
has second messenger (e.g. cAMP);  
  
named example of steroid hormone (adrenal cortical hormones, hormone forms of vitamin D and androgens and estrogens);  
receptor-hormone complex inside the cell;  
translocation to the nucleus;  
DNA inducer / is a transcriptional activator;  
requires a specific carrier protein to be carried in blood;

**[4 max]**

- (b) produced in hypothalamus;  
via neurosecretory cells;  
passes from hypothalamus to pituitary;  
attached to carrier protein / neurophysin;  
(stored) in posterior pituitary / neurohypophysis;  
released under stimulus by osmoreceptors in hypothalamus;  
osmoreceptors stimulated by high blood plasma concentration / reduced blood pressure;  
increases water reabsorption (in kidneys);  
site of action is collecting duct;  
promotes constriction of blood vessels;  
increases blood pressure;  
there is a negative feedback control of ADH secretion;  
*Only [2 max] can be awarded in relation to the last four points.*  
*Accept reference to vasopressin instead of ADH.*

**[6 max]**

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